W9132T-04-C-0023

Midterm Report
US State Department PEM Demonstration Project

Proton Exchange Membrane (PEM) Fuel Cell Demonstration
Of Domestically Produced PEM Fuel Cells in Military Facilities

US Army Corps of Engineers
Engineer Research and Development Center
Construction Engineering Research Laboratory
Broad Agency Announcement CERL-BAA-FY03

Headquarters:

1080 Holcomb Bridge Rd
Suite 100-175
Roswell, GA 30076
Ph (770) 650-6388

US Embassy
Residence
London, UK
October 2, 2006

California:

74837 Diamond Bar Rd
29 Palms, CA 92277
Ph (760) 367-5005

Executive Summary

Under terms of its FY'03 DOD PEM Demonstration Contract with ERDC/CERL, LOGANEnergy installed and is operating a Plug Power GenSys 5kWe Combined Heat and Power (CHP) fuel cell power plant at the US Embassy Residence, London, UK. The fuel cell is sited at the rear of the building adjacent to the mechanical room, and is electrically configured to provide grid parallel/grid independent service to the facility. The fuel cell provides up to 8,000 Btu/h to the facility's hot water system. LOGAN has hired Southern Electrical Contracting (SEC) to provide on-site services. SEC is a subsidiary of Scottish and Southern Energy, PLC, the UK's largest utility service provider. Two SEC employees received PEM service and maintenance training in the US to enable them to provide product support during the demonstration period. It is anticipated that the project will add $46.10 in energy costs to the facility during the period of performance.

The POC for this project is Geoff Miller, US Embassy facilities maintenance manager, whose coordinates are: MillerGE@state.gov, Telephone 44-207-894-0246.

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City of AtlantaGeorgia PowerGeorgia Gas Co.($0.010)($0.035)($698.34)

Proposal – Proton Exchange Membrane (PEM) Fuel Cell Demonstration of Domestically Produced Residential PEM Fuel Cells in Military Facilities

1.0 Descriptive Title

LOGANEnergy Corp. Small Scale PEM 2004 Demonstration Project DOS US Embassy Residential Building, London, UK.

2.0 Name, Address and Related Company Information

LOGANEnergy Corporation
1080 Holcomb Bridge Road
BLDG 100- 175
Roswell, GA 30076
(770) 650- 6388

DUNS 01-562-6211
CAGE Code 09QC3
TIN 58-2292769

LOGANEnergy Corporation is a private Fuel Cell Energy Services company founded in 1994. LOGAN specializes in planning, developing, and maintaining fuel cell projects. In addition, the company works closely with manufacturers to implement their product commercialization strategies. Over the past decade, LOGAN has analyzed hundreds of fuel cell applications. The company has acquired technical skills and expertise by designing, installing and operating over 30 commercial and small-scale fuel cell projects totaling over 7 megawatts of power. These services have been provided to the Department of Defense, fuel cell manufacturers, utilities, and other commercial customers. Presently, LOGAN supports 30 Phosphoric Acid Fuel Cells (PAFC) and PEM fuel cell projects at 21 locations in 12 states, and has agreements to install 22 new projects in the US and the UK over the next 18 months.

3.0 Production Capability of the Manufacturer

Plug Power manufactures a line of PEM fuel cell products at its production facility in Latham, NY. The facility produces three lines of PEM products including the 5kW GenSys5C natural gas unit, the GenSys5P Liquid Propane (LP) Gas unit, and the GenCore 5kW standby power system. The current facility has the capability of manufacturing 10,000 units annually. Plug Power will support this project by providing remote monitoring, telephonic field support, overnight parts supply, and customer support. These services are intended to enhance the reliability and performance of the unit and achieve the highest possible customer satisfaction. Vinny Cassala is the Plug Power point of contact for this project. His phone number is 518.782.7700 ex1228, and his email address is vincent_cassala@plugpower.com.

4.0 Principal Investigator(s)

Name Samuel Logan, Jr. Keith Spitznagel
Title President Vice President Market Engagement
Company Logan Energy Corp. Logan Energy Corp.
Phone 770.650.6388 x 101 860.210.8050
Fax 770.650.7317 770.650.7317
Email samlogan@loganenergy.com kspitznagel@loganenergy.com

5.0 Authorized Negotiator(s)

Name Samuel Logan, Jr. Keith Spitznagel
Title President Vice President Market Engagement
Company Logan Energy Corp. Logan Energy Corp.
Phone 770.650.6388 x 101 860.210.8050
Fax 770.650.7317 770.650.7317
Email samlogan@loganenergy.com kspitznagel@loganenergy.com

6.0 Past Relevant Performance Information

Contract: PC25 Fuel Cell Service and Maintenance Contract #X1237022

Merck & Company
Ms. Stephanie Chapman
Merck & Company
Bldg 53 Northside
Linden Ave. Gate
Linden, NJ 07036
(732) 594-1686

In November 2002 Merck & Company issued a four-year contract to LOGAN to provide fuel cell service, maintenance and operational support for one PC25C fuel cell installed at their Rahway, NJ plant. During the contract period the power plant has operated at 94% availability. LOGAN performs the quarterly and annual service prescribed by the UTC, and performs other maintenance as required. The periods of unavailability are chiefly due to persistent inverter problems that seem to be endemic to the Toshiba power conditioning balance of the system. Field modifications and operating adjustments have largely cured the problem. Quarterly service events take 10 hours to complete with the unit under load, and the annual event takes approximately 35 hours with the unit shut down.

Contract: Plug Power Service and Maintenance Agreement to support one 5kWe GenSys 5C and one 5kWe GenSys 5P PEM power plant at NAS Patuxant River, MD.

Plug Power
Mr. Scott Wilshire.
968 Albany Shaker Rd.
Latham, NY 12110
(518) 782-7700 ex 1338

LOGAN performed the start-up of both units after Southern Maryland Electric Cooperative completed most of the installation work. The units are located at residential sites at Patuxant

River Naval Air Station, MD and operate in standard gird connected/grid independent configurations. Both operate at 4.5kWe and have maintained 98% availability. The units, S/Ns 241 and 242 are two of the very latest GenSys models to reach the field. S/N 242 is Plug Power's first LPG fueled system to go into the field. Both have set new performance standards, and raised expectations for near term commercial viability for this product. Operations to date are indicative of the success of the various test and evaluation programs that have been conducted over the past two years.

Contract: A Partners LLC; Commercial PC25 Fuel Cell Project Design, Installation and 5-year service and maintenance agreement.

Mr. Ron Allison
A Partners LLC
1171 Fulton Mall
Fresno, CA 93721
(559) 233-3262

On April 20, 2004 LOGAN completed the installation of a 600kWe PC25C Combined Heat and Power (CHP) fuel cell installation in Fresno, CA. The system operating configurations allow for both grid parallel and grid independent energy service. The grid independent system is integrated with a Multi Unit Load Sharing (MULS) electronics package and static switch, which initial development was funded by ERDC CERL in 1999. This is the third fuel cell installation that uses the MULS System. The thermal recovery package installed in the project includes a 100-ton chiller that captures 210 degree F thermal energy supplied by the three fuel cells to support cooling loads on the first three floors of the host facility. The fuel cells also provide low-grade waste heat at 140 degrees F that furnishes thermal energy to 98 water source heat pumps located throughout the 12-story building during the winter months.

7.0 Host Facility Information

The US Embassy Residence is home to over 50 US London Embassy staff and family members. The building is located next door to the historic Abby Road recording studio that produced many of the Beatles 1970s recordings. This facility was selected to host the UK PEM demonstration project from a selection of four potential sites that were suggested by Geoff Miller, US Embassy facilities manager, for the following reasons; (a) it provides an accessible location where the PEM unit may be easily sited, (b) natural gas is conveniently located at the building, (c) the facility has a continuous thermal load that will optimize the fuel cell's thermal output, (d) fuel cell integration with the facility's existing energy services do not require costly modifications, and (e) Embassy facilities staff are highly supportive of the project.

LOGAN has enlisted the support of Scottish and Southern Utility (S&S) to take the lead in procuring local support for the project to insure timely submission and process of all permits that may be required to install and operate the PEM fuel cell.

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The Oversees Building Office (OBO) of the Department of State located in Arlington, VA operates the US Embassy Residence property. LOGAN worked diligently over the past year to win the support of OBO to proceed with the project.

8.0 Fuel Cell Installation

The photo at right shows the Plug Power 100VAC 50Hz GenSys 5C PEM 5kW fuel cell located within the parking garage of the US Embassy facility. The site is convenient to electrical, mechanical and thermal connections located in a utility room (behind the fuel cell) to the right in the photo. The area will be restored to its original condition after the demonstration. LOGAN utilized both SEC Contractors and S&S Utility to insure that the project adheres to local codes and standards, and that it had all of the requisite permits prior to construction and operation of the fuel cell site.

Figure 1 – Fuel Cell Location

9.0 Electrical System

The Plug Power GenSys 5C PEM fuel cell power plant provides both gird parallel and grid independent operating configurations for site power management. This capability is an important milestone in the development of the GenSys5 product and for the PEM Program itself, as it is a significant developmental step on the pathway to product commercialization. The natural gas unit selected for this project has a power output of 100 VAC at 50 Hz in order to match the actual operating conditions at the UK site. This was accomplished by making setpoint adjustments to the MP-5 inverter controller software to convert it to a 50 Hz machine from the normal 60 Hz system typical of US installations. The fuel cell was interconnected with the grid at a new 100-amp circuit breaker installed in the facility's existing electric service panel. A new emergency panel was placed adjacent to the existing service panel and several lighting circuits were attached to utilize the fuel cell's stand-by power capability. In the Figure 2 photo, electrical

Figure 2 – Electrical Connection

conductors can be seen at the lower right side of the fuel cell cabinet, proceeding across in front at the base of the cabinet over to the floor mounted transformer enclosures at left, and continuing up the wall to a disconnect enclosure (see Figure 3.)

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10.0 Thermal Recovery System

While operating at a set point of 2.5 kWh, the fuel cell will provide 7800 Btuh at approximately 140 degrees F. The thermal piping loop in and out of the fuel cell can be seen in the Figure 4 photo. A small commercial heat exchanger was installed at the cold water feed to the hot water storage tanks allowing the fuel cell to reject its heat into the facility's domestic hot water system.

Figure 5 Existing Hot Water

Figure 4 – Thermal Piping to Fuel el

11.0 Data Acquisition System

LOGAN has installed a Connected Energy Corporation (CEC) w
Acquisition (SCADA) system that provides high-speed access t
The schematic drawing seen below in Figure 6 describes the a
support the project. The system provides a comprehensive d
remote control, alarming, notification, and reporting functions
of fuel cell operating parameters on functional display screens
management, as well as external instrumentation inputs inclu
temperatures. CEC's Operations Control Center, located in Ro
means of a Virtual Private Network that links the fuel cell to th

Figure 5 – Web Monitoring

To view the operation of this unit, log on to https://www.enerview.com/EnerView/login.asp Then login as: logan.user and enter the password: guest. Select the box labeled CERL, or navigate other LOGAN sites using the tool bars or html keys.

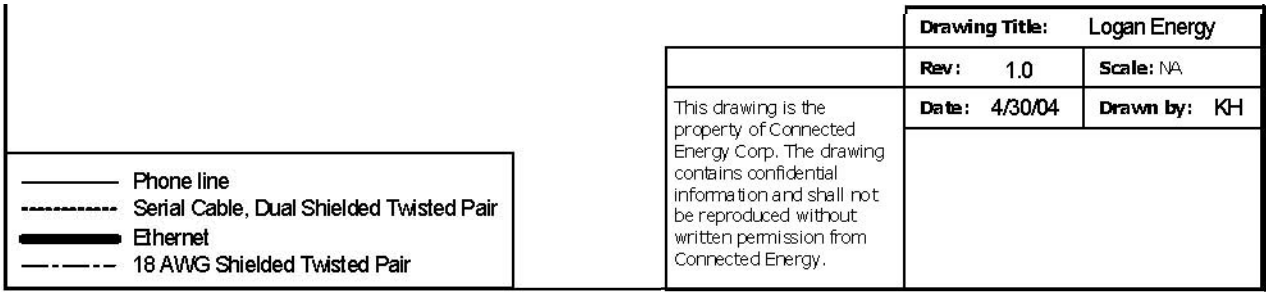

Figure 6 – CEC Web Enabled SCADA Terminal Hardware

12.0 Fuel Supply System

This GenSys unit operates on natural gas. A natural gas line was already existing nearby to the fuel cell area. The gas supply line comes from overhead, proceeding to the wall adjacent to the fuel cell, down the wall to the newly installed gas meter (shown in the Figure 7 photo), and on down to the floor over to the fuel cell.

Figure 7 – Gas Meter

13.0 Installation Costs

March Air Reserve Base Building 400

Project Utility Rates		Utility
1) Water (per 1,000 gallons)	$12.13	City of Atlanta
2) Utility (per KWH)	$0.0500	Georgia Power
3) Natural Gas (per MCF)	$6.63	Georgia Gas Co.

First Cost	Estimated	Actual
Plug Power 5 kW GenSys5C	$ 65,000.00	$ 65,000.00
Shipping	$ 1,800.00	$ 1,060.00
Installation electrical	$ 1,250.00	$ 924.00
Installation mechanical & thermal	$ 3,200.00	$ 1,700.00
Watt Meter, Instrumentation, Web Package	$ 3,150.00	$ 2,950.00
Site Prep, labor materials	$ 925.00	$ 1,125.00
Technical Supervision/Start-up	$ 8,500.00	$ 13,860.00
Total	**$ 83,825.00**	**$ 86,619.00**
Assume Five Year Simple Payback	$ 16,765.00	$ 17,323.80

Forcast Operating Expenses	Volume	$/Hr	$/ Yr	
Natural Gas MCF/ hr @ 2.5kW	0.03	$ 0.22	$ 1,716.47	
Water Gallons per Year	14,016		$ 170.01	
Total Annual Operating Cost				$ 1,886.49

Economic Summary			
Forcast Annual kWH		19710	
Annual Cost of Operating Power Plant	$	0.096	kWH
Credit Thermal Recovery Rate		($0.010)	kWH
Project Net Operating Cost	$	0.085	kWH
Displaced Utility cost	$	0.050	kWH
Energy Savings (Cost)		($0.035)	kWH
Annual Energy Savings (Cost)		($698.34)	

Explanation of Calculations:

Actual First Cost Total is a sum of all the listed first cost components.

Assumed Five Year Simple Payback is the Estimated First Cost Total divided by 5 years.

Forecast Operating Expenses:

Natural gas usage in a fuel cell system set at 2.5 kW will consume 0.033 thousand cubic feet per hour. The cost per hour is 0.033 Mcf per hour x the cost of NG to the site per MCF at $6.55. The cost per year at $1704.13 is the cost per hour at $0.22 x 8760 hours per year x 0.9. The 0.9 is for 90% availability.

The fuel cell systems set at 2.5 kW will consume 1.6 gallons of water per hour through the Deionized Water (DI) panel. The total volume of water consumed at 14,016 gallons per year is 1.6 gph x 8760 hours per year. The cost per year at $11.91 is 14,016 gph x cost of water to the site at $0.85 per 1000 gallons.

The Total Annual Operating Cost, $1716.04 is the sum of the cost per year for the natural gas and the cost per year for the water consumption.

Economic Summary:

The Forecast Annual kWh at 19,710 kWh is the product of the 2.5 kW set-point for the fuel cell system x 8760 hours per year x 0.9. The 0.9 is for 90% availability.

The Annual Cost of Operating the Power Plant at $0.087 per kWH is the Total Annual Operating Cost at $1716.04 divided by the forecast annual kWh at 19,710 kWh.

The Credit Annual Thermal Recovery at -$0.020 is 7800 divided by 3414. This is then multiplied by 0.9 x 0.1x the cost of electricity at $0.065 per kWh x (-1). As a credit to the cost summary, the value is expressed as a negative number.

The Project Net Operating Cost is the sum of the Annual Cost of Operating the Power Plant plus the Credit Annual Thermal Recovery.

The Displaced Utility Cost is the cost of electricity to CERL per kWh.

Energy Savings (cost) equals the Displaced Utility Cost minus the Project Net Operating Cost.
Annual Energy Savings (cost) equals the Energy Savings x the Forecast Annual kWh.

14.0 Acceptance Test

The UK Embassy fuel cell system number SU01B000000318 was officially commissioned by LOGAN technicians on April 20, 2006 after passing its 8-hour acceptance test that day. Kilowatt output typically recorded by the Connected Energy monitoring system was not available at the time of commissioning. Kilowatt output from the earliest monitoring is shown in Figure 7.

Appendix

Monthly Performance Summary

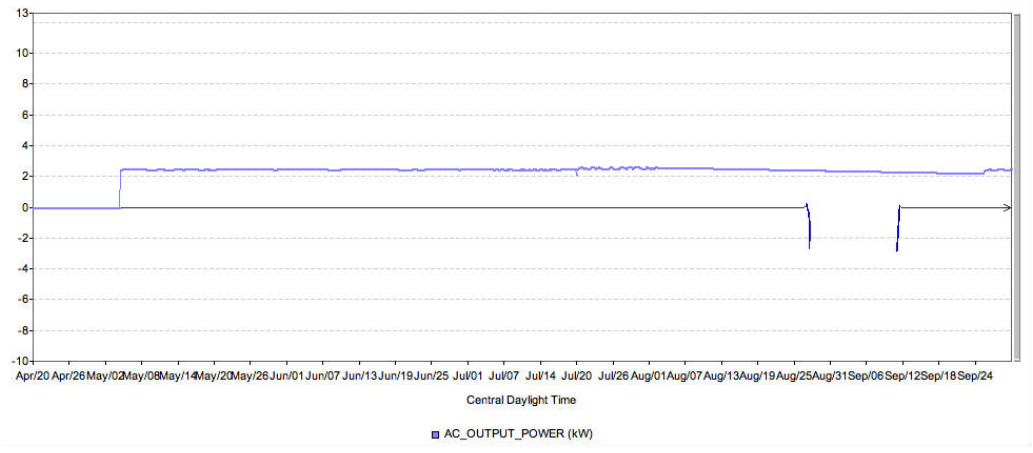

Figure 7 – KW Output (from start of data collection 04 May 2006)

April Summary

After completing the installation of the Abbey Road Residence fuel cell in April of 2006, LOGAN technicians pursued an 8-hour acceptance test and commissioning. With the completion of all the necessary installation tasks late in April, LOGAN administered an 8-hour acceptance test and officially commissioned the fuel cell on April 20, 2006. The Abbey Road Residence fuel cell ran at 100% availability for the remainder of April after the commissioning.

Shutdown Date(s): None
Replaced Component: None

May Summary

The Abbey Road Residence fuel cell ran at 100% availability for the month of May.
Shutdown Date(s): None
Replaced Component: None

June Summary

The Abbey Road Residence fuel cell ran at 100% availability for the month of June, and has run at 100% availability for the duration of the demonstration.
Shutdown Date(s): None.
Replaced Components: None.

July Summary

The Abbey Road Residence fuel cell ran at 100% availability for the month of July, and has run at 100% availability for the duration of the demonstration
Shutdown Date(s): None.
Replaced Components: None.

August Summary

The Abbey Road Residence fuel cell ran at 60% availability for the month of August. In early August, the unit shutdown due to sulfur breakthrough; detected by temperature swings in the reformer. The sulfur removal canister was replaced.
Shutdown Date(s): 4 Aug – 16 Aug 2006
Replaced Components: Desulfurizer, air filter, DI water filter (12,000 kWh maintenance kit)

September Summary
The fuel cell ran at 100% availability for the month of September.
Shutdown Date(s): None.
Replaced Components: None.

System Number:		**SU01B000000318**							
Site Name:		**United Kingdom**							
Commision Date:		**4/20/06**							
Lower Heating Value:									
Month	**Run Time (Hours)**	**Time in Period (Hours)**	**Availability (%)**	**Energy Produced (kWe-hrs AC)**	**Output Setting (kW)**	**Average Output (kW)**	**Capacity Factor (%)**	**Fuel Usage (SCF)**	**El Ef c**
insert month	*insert operating hours*	*insert hours in month*	**1*	*insert produced energy*	*insert output setting*	**2*	**3*		
April, 2006	**264**	**264**	**100%**	**740.4**	**2.5**	**2.80**	**56.09%**	**119**	**2**
May, 2006	**744**	**744**	**100%**	**1839.6**	**2.5**	**2.47**	**49.45%**	**293**	**2**
June, 2006	**720**	**720**	**100%**	**1840.5**	**2.5**	**2.56**	**51.12%**	**299**	**2**
July, 2006	**744**	**744**	**100%**	**1859.0**	**2.5**	**2.50**	**49.97%**	**310**	**2**
August, 2006	**447**	**744**	**60%**	**1135.0**	**2.5**	**2.54**	**50.74%**	**185**	**2**